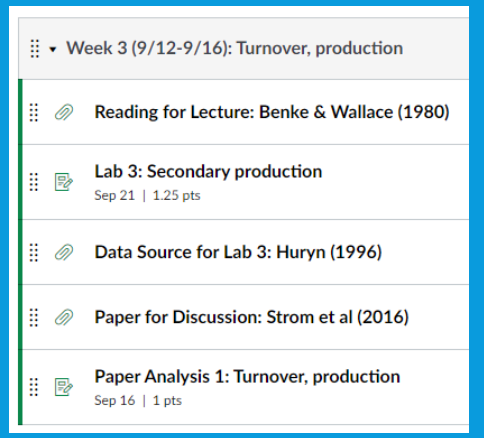
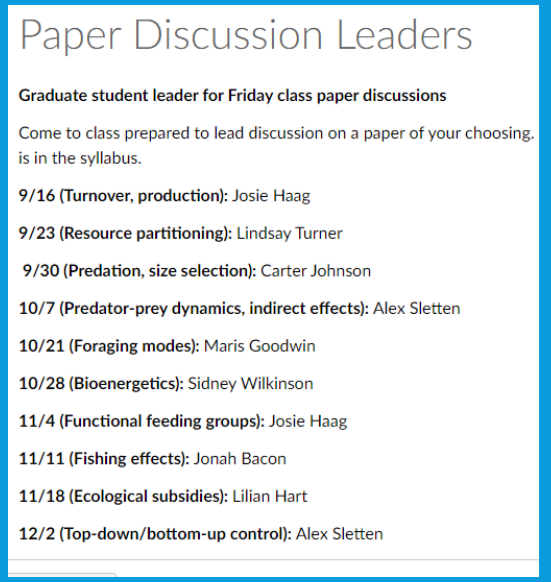
ANNOUNCEMENTS

- Feedback on Lab 1 will be posted soon (def. before class Monday).
  - Use this to adapt future lab exercises as needed.
  - Mea culpa: They are "Food web diagrams" in formal writing.
    "Horrendograms" is shorthand
- Paper for Friday, 9/16 is up on Canvas (thanks Josie)
  - Remember: 1st paper analysis due in a week (see assignment on Canvas)
  - Lindsay: on the clock paper w/in next week
- Paper for Monday on Canvas
  (Benke & Wallace 1980)
- How is Lab 2 going?





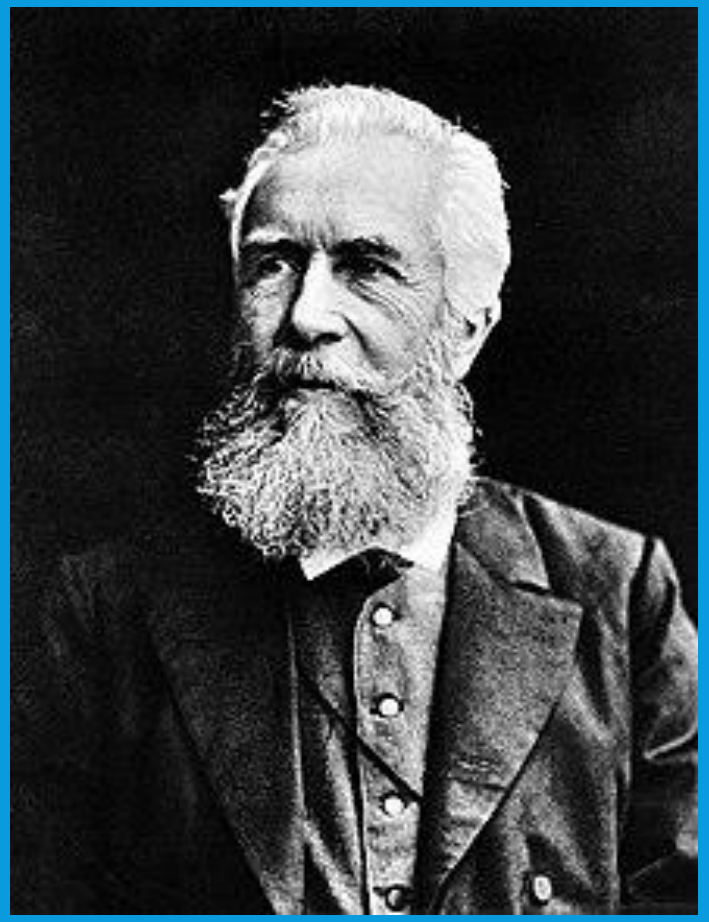
AQUATIC FOOD WEB ECOLOGY

9 September 2022

THE BASICS: WHAT IS “ECOLOGY”?

THE BASICS: WHAT IS "ECOLOGY"?

- Greek: Oikos, Logos
- "House", "Study"
- The study of the home
- Ernst Haeckel (German, 1866)
- Studied aquatics, and other things



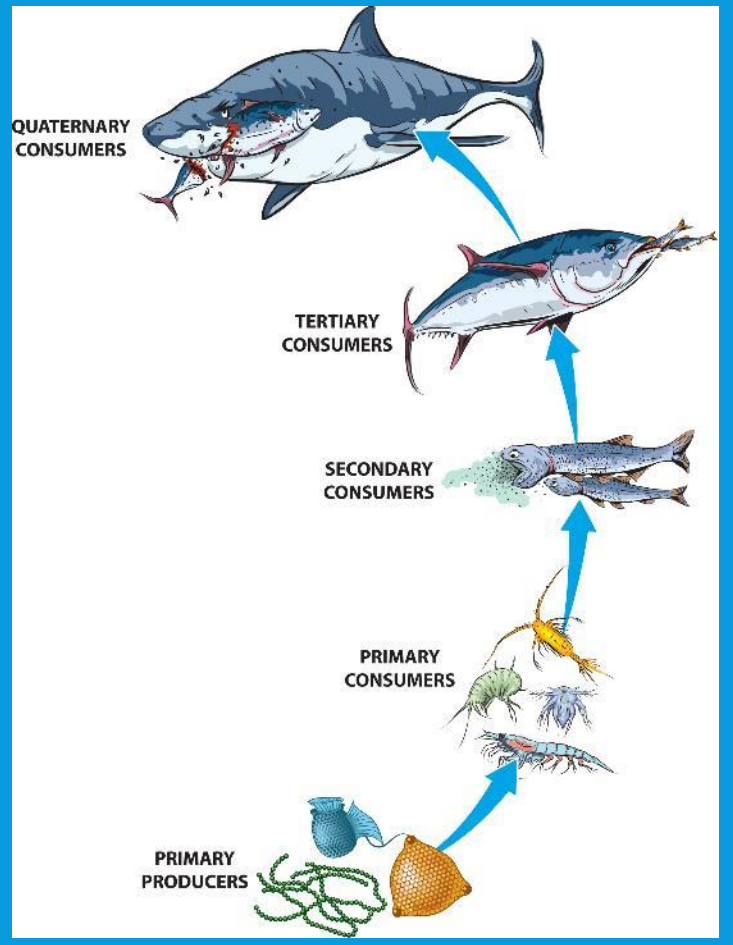
THE BASICS: WHAT IS "ECOLOGY"?

- More technically: The study of how organisms interact with one another and with their environment

THE BASICS: WHAT IS A "FOOD WEB"?

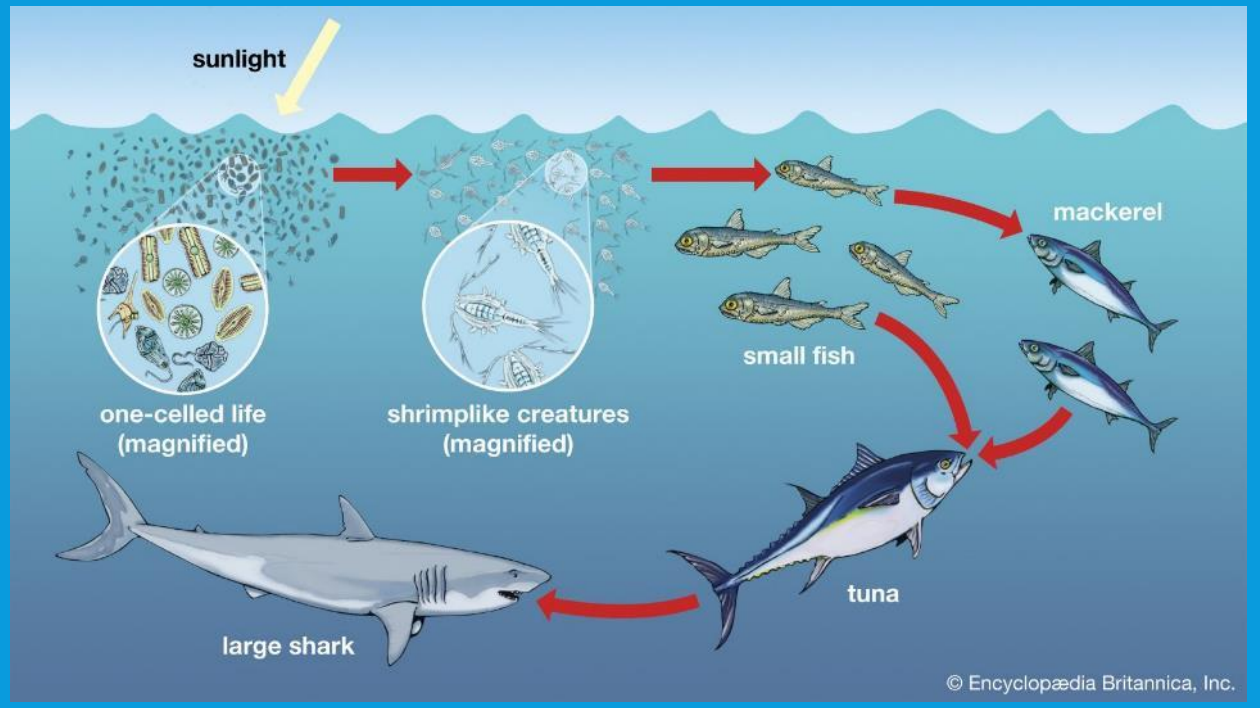
- Food chain
- Charles Elton (English, 1927)

- Textbook: Animal Ecology
- Not an aquatics guy, but did work in the Arctic
- "Eltonian pyramid"



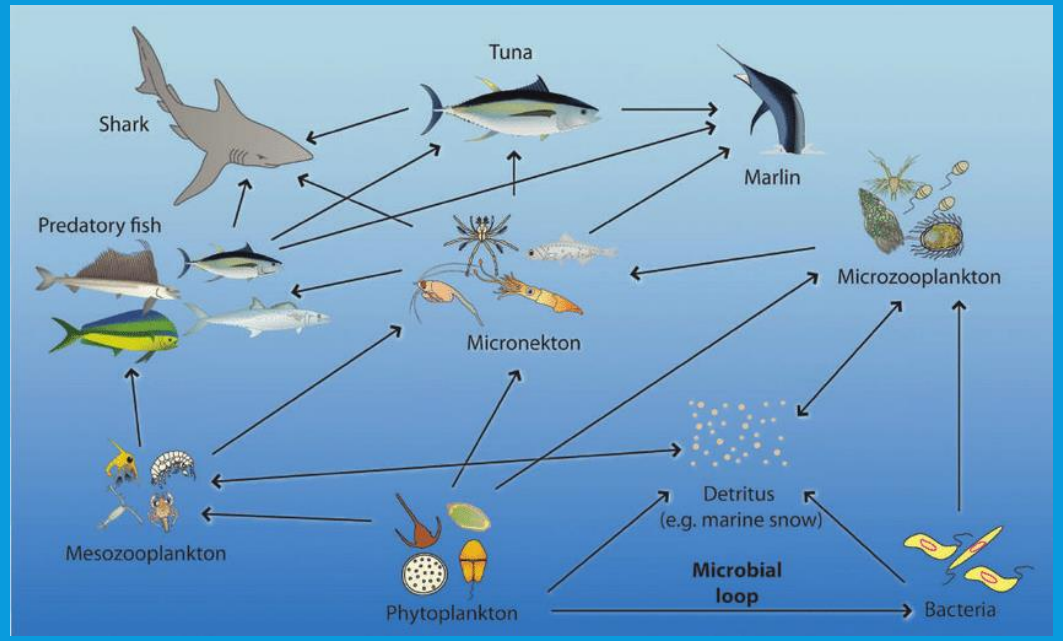
THE BASICS: WHAT IS A "FOOD WEB"?

- Food chain
- Charles Elton (English, 1927)
- Revised shortly thereafter to food cycle



THE BASICS: WHAT IS A "FOOD WEB"?

- Food chain
- Charles Elton (English, 1927)
- Revised shortly thereafter to food cycle
- Revised shortly thereafter to food web

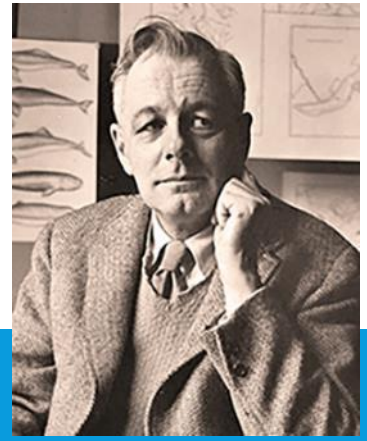


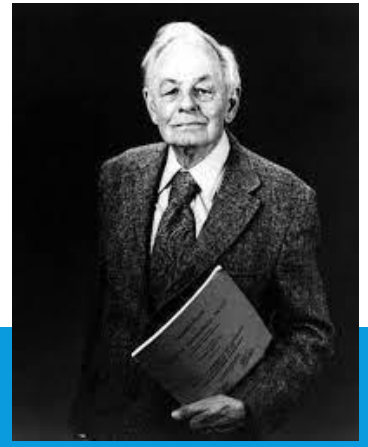
WHY *AQUATIC* FOOD WEB ECOLOGY?

WHY *AQUATIC* FOOD WEB ECOLOGY?

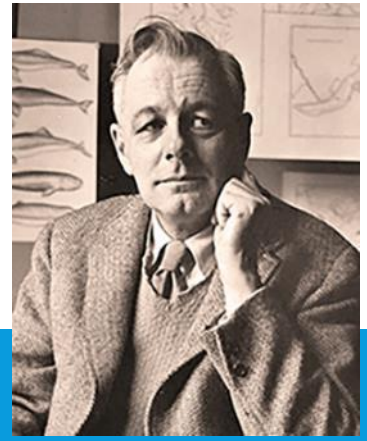
- Long history in lakes (esp. Germans, Russians, some English)
  - Natural contained "test tubes"
  - Extension from there into streams, rivers, seas, oceans?
  - Oceanic food webs also somewhat simple, easy to depict?
- Also, why not aquatic food webs?
  - Logical inclination to understand function of all habitats
- Legacies of some very smart individuals

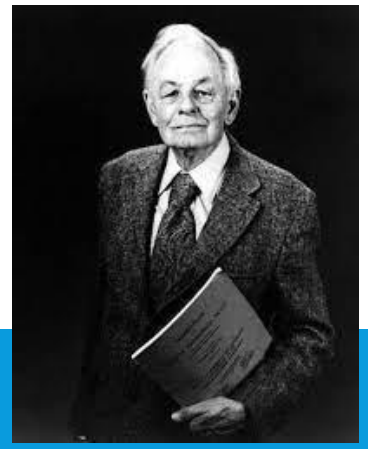
G.E. HUTCHINSON





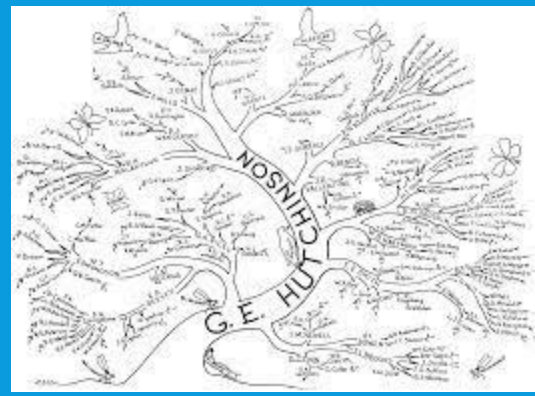
G.E. HUTCHINSON

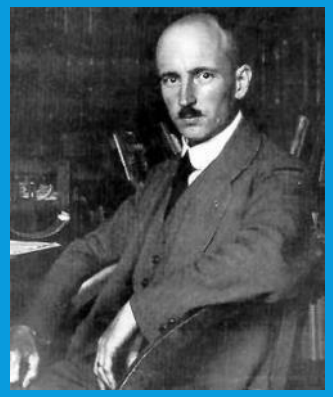




- Elton writes his book (again, 1927)
- August Thienemann (German, 1925) writes his book, *Die Binnengewässer Mitteleuropas*
  - *(The inland waters of middle Europe)*
- Hutchinson reads these on a plane to start a postdoc at Yale in 1927
  - "I had, in fact, become a limnologist."

Sees potential for lakes as ideal ecological study systems





Thienemann

- Hutchinson becomes "the father of modern ecology"
  - Two most famous papers: "Concluding remarks" and "Homage to Santa Rosalia"
  - Modern niche concept, species richness

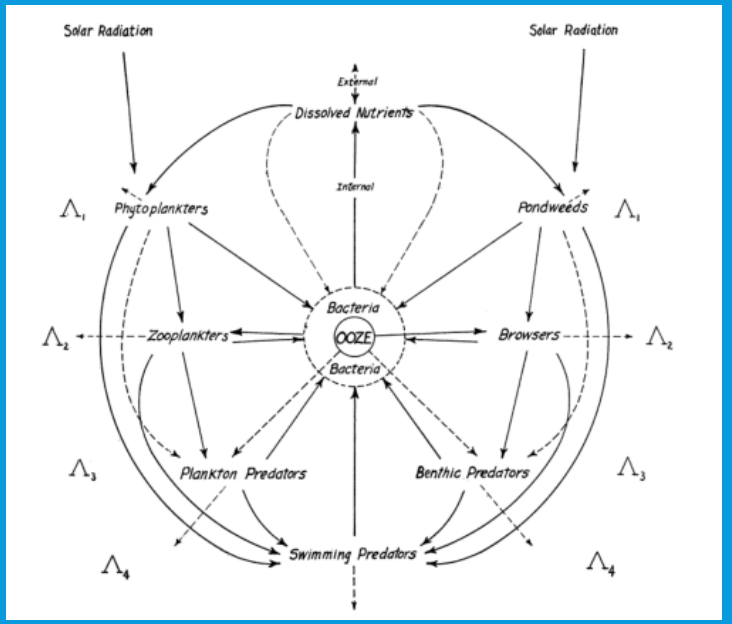
LAKE FOOD WEBS

- Hutchinson advises a postdoc named Raymond Lindeman
- Lindeman got a PhD at Minnesota, spent 5 years kicking around a lake
- Goes to publish, reviewers say it's too general, not detailed enough
- Hutchinson pushes back, paper is published
- Becomes foundational paper in all of food web ecology
- Lindeman dies in 1942 @age 27 from liver failure

- …wow, we just read that paper!

THE TROPHIC-DYNAMIC CONCEPT (LINDEMAN 1942)

- Argues for the importance of energy flow through trophic levels in controlling ecosystem assembly and change (i.e., "succession.")
- 10% rule. Provides energetic numbers to the Eltonian pyramid
  - Only 10% of the biomass consumed from the lower trophic level is actually incorporated into biomass at the higher trophic level.
    - E.g., if a shark eats a seal, only 10% of that seal biomass will actually become shark biomass. The rest is respired, egested, etc.
- Furthers concept of "ecosystem" and "succession"
  - Ecosystem: Developed by Sir Arthur Tansley (English, 1935)
    - Inextricable link between organisms and habitat
  - Succession: Henry Chandler Cowles (American, 1899)
    - Predictable pattern or organism response with time as habitat develops
- Figure 1 (right) maybe the most famous food web in the field



MARINE FOOD WEBS (PAINE 1980 READING)

- Paine: Studies at Michigan, takes a class from Frederick E. Smith
  - Smith: Coauthor on famous HSS paper, asks "why is the world green?"
    - (if there are so many consumers, why do plants still exist?)
      - Because predators eat the consumers!
    - Smith: A student of Hutchinson
  - Paine moves to Washington, gets interested in starfish
  - By keeping starfish out of an area, gets totally overrun by one species. When starfish are kept in, many species co-habit. Paper: Paine (1966) *American Naturalist*
  - Keystone species concept: "…patterns of species occurrence, distribution and density are disproportionately affected by the activities of a single species of high trophic status."

DISCUSSION

- From Paine 1980:

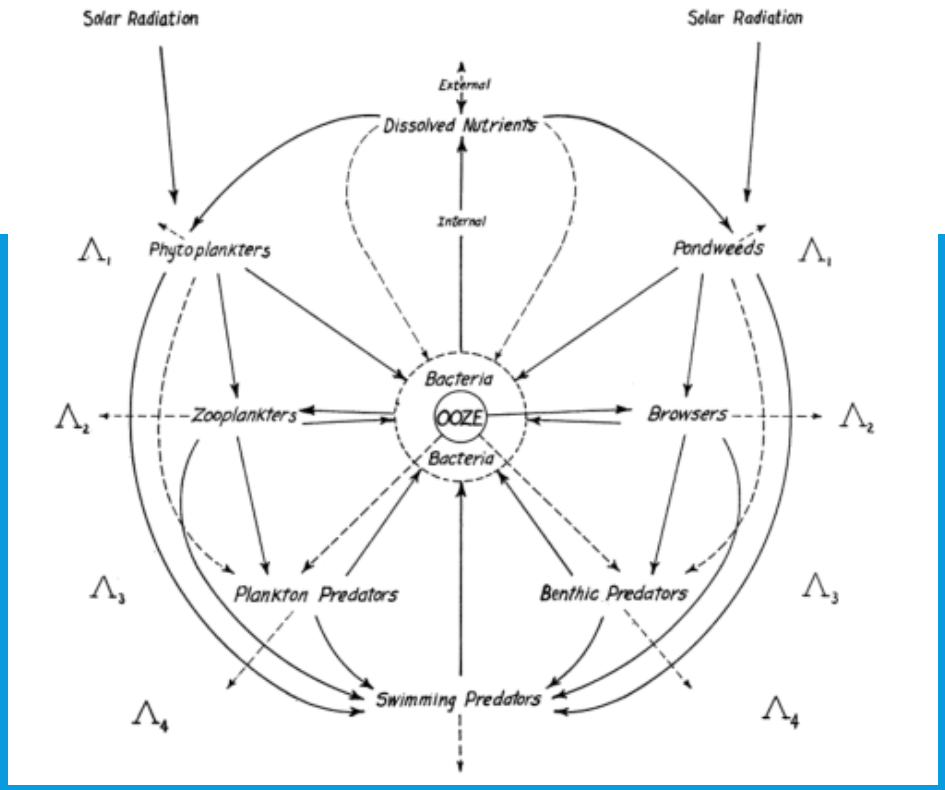
> *Trophic levels*. The term is one of convenience but assignment to a level often cannot be made. Elton (1927) both recognized and paid particular attention to the obscuring influences of body size, and gave numerous examples of omnivores. Lindeman (1942) identified specific levels, but clearly stated that they became less precise as one moves up the food chain. Darnell (1961), amongst many, has argued for the prevalence of rampant trophic opportunism: consumer nutrition is often derived from numerous prey categories which themselves cannot be assigned to any single level. Although many species are more eclectic in their dietary choices, nonetheless it is impossible to defend the sanctity of the trophic level concept.

- What did we learn about trophic levels in lab 1? Are those data consistent or inconsistent with Paine's statement here?
- Are trophic levels useful?

DISCUSSION

- From Lindeman 1942:

- Do you agree with the peer reviewers who originally rejected this manuscript for not having enough detail?
- Why is this figure so well-remembered?
- Based on our exercises in labs 1 and 2, how has the field advanced? Are these big advances, or small ones?



DISCUSSION

- From Paine 1980:

> I wish to close with a final observation: pattern is generated by process. One embodies static description, the other more subtle and dynamical events. Food webs along with their associated cross-links provide a realistic framework for understanding complex, highly interactive, multispecies relationships. I believe the next generation of models must be more sensitive to interaction strength, less so to trophic complexity, for the answers to questions on the stability properties of complex, natural communities increasingly violated by mankind are vital, and our time is short.

- What processes drive patterns in aquatic food webs?
- Does thinking about process affect how we think about the food webs we study?
  - How?

DISCUSSION

- From Paine 1980
- What are weak vs. strong interactions in Paine's description?
- Are these equally or unequally important in food webs and in structuring food webs? Why?
- For a given food web, how many interactions are strong vs. weak? Does this ratio matter?
- Is a food web more stable with strong or weak interactions? From a human management perspective, should we seek to maintain or restore one over the other?